Regular paper

THE INFLUENCE OF POWER SYSTEMS ON TELECOMMUNICATION SYSTEMS

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Abstract: This work is about influence of strong electromagnetic fields of power line, as a part of a system, on telecommunication line. Two characteristic cases are taken, when the power line is used only for power transportation and when power line is used also for transporting data. (Broadband over power line). In first case unwanted current and voltage may be induced on telecommunication line. In second case unavoidable radio frequency leakage emissions impacts near radio devices.

Keywords: Electromagnetic fields, EMC, EMI, Broadband over power line.

INTRODUCTION

Electromagnetic compatibility (EMC) means that a device is compatible with its electromagnetic environment and it does not emit levels of EM energy that cause electromagnetic interference (EMI). Electromagnetic interference is a serious and increasing form of environmental pollution. Various forms of EMI may cause electrical and electronic malfunctions and can prevent the proper use of the radio frequency spectrum. In data communication, excessive electromagnetic interference (EMI) hinders the ability of remote receivers to successfully detect data packets. The end result is increased errors, network traffic due to packet retransmissions, and network congestion.

Scottish and Southern Energy plc, a major UK power utility, has conducted several trials of access PLT products. This PLT network trial uses equipment supplied by the American company, Amperion PLT. This project was designed to update on the nature and extent of the unavoidable radio frequency leakage emissions that radiate from modern Power Line Telecommunications networks. Particular interests were the rate at which PLT leakage emission levels decay with distance from their source.

INFLUENCE OF TRANSMISSION LINE ON TELECOMMUNICATION LINE

The coupling between power lines and telecommunications cables may be due to one or more of the following mechanisms:

- conductive coupling
- capacitive coupling
- inductive coupling

Conductive coupling occurs when two circuits have a common branch. If Circuit 1 is a power line and Circuit 2 is a telecommunication channel, the parasitic current introduced into Circuit 2 from Circuit 1 is detrimental because of its intensity. Conductive coupling is fairly common when the bonding and grounding systems used for power and telecommunications are not sufficiently isolated.

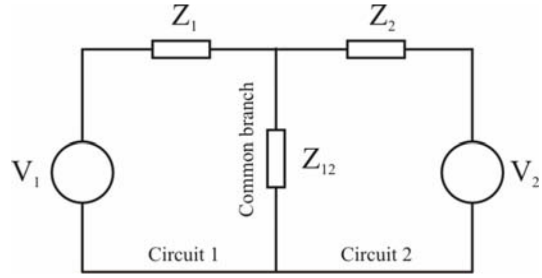

Fig. 1 - *Conductive coupling between a power line and a telecommunications channel*

Capacitive coupling occurs between power and telecommunications cables carried in parallel for some extent in a given installation. The capacitance between the two lines, referred to in Figure 2 as C_{PT} (Power line to Telecommunications line capacitance), is caused by coupling between these two circuits. The value of this capacitance will vary with the distance between circuits – higher for short distances and lower for large distances. To reduce the voltage noise level due to the capacitive coupling between channels, either the capacitance C_{PT} can be decreased (decreasing the capacitive coupling) or the impedances Z_{PT} and Z_0 can be increased.

Other elements shown in Figure 2 include the Power line to Ground Capacitance (C_{PG}), Telecommunications Line to Ground Capacitance (C_{TG}), and the impedance between the Power Line and the Telecommunications Line (Z_{PT}).

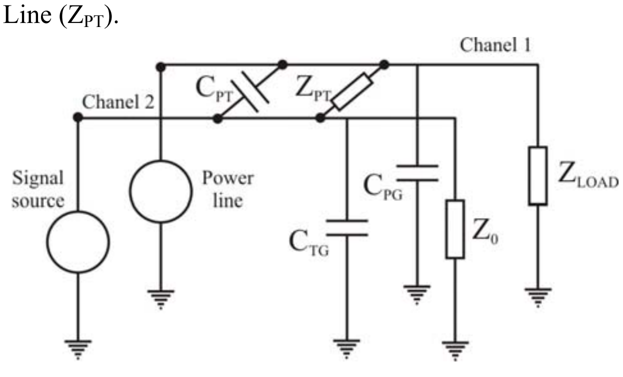

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Fig. 2 - *Capacitive coupling between a power line and a telecommunications channel*

Inductive coupling occurs via the mutual inductance (L_{mutual}) between two or more circuits or channels as represented by the simplified model shown in Figure 3. When current flows in a circuit terminated with a load, it produces a magnetic flux proportional to the current. This magnetic flux may induce noise voltage (VN) into an adjacent channel, generating a loop current in the disturbed circuit. This type of coupling is one of the most common. The geometry of the conductors, as well as the geometric range between two lines in space, determines the value of Lmutual and, consequently, the intensity of the inductive coupling. Another important factor is the environment that contains the lines.

In order to reduce the effect of inductive coupling between circuits, it is important to maintain cable geometry along the entire channel length and to keep adequate separation between circuits.

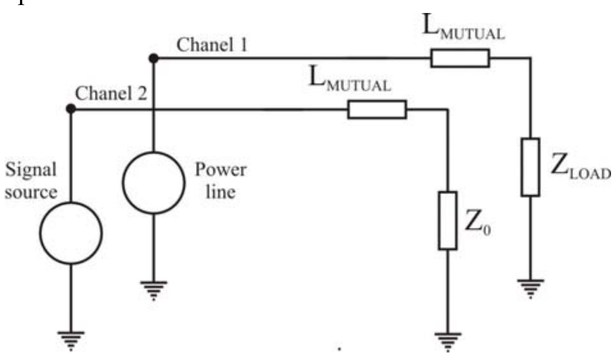

Fig. 3 - *Inductive coupling between a power line and a telecommunications channel*

The combined effects are represented in Figure 4, where Z_{GG} is the impedance ground-to-ground between the telecommunications line and the power line as a result of conductive coupling between these two lines.

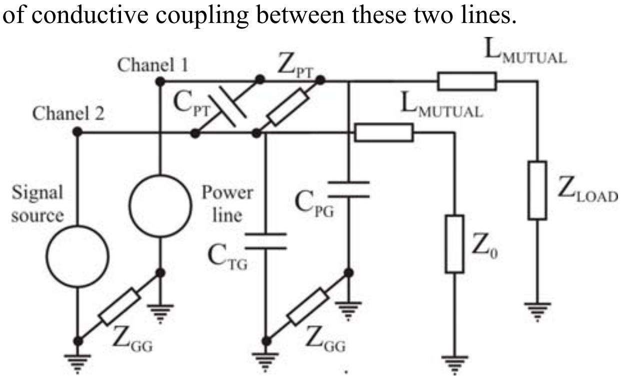

Fig. 4 - *Combined coupling effects*

Influence of PLT (BPL) on telecommunication systems

The launch power of the Amperion PLT equipment, in accordance with normal practise and FCC part 15 measurement requirements, was set to its maximum value of -50 dBm/Hz during the measurement. Leakage emission levels from the Amperion equipped 11kV overhead line were found to be up to 8dB in excess of the FCC Part 15 emission limits for frequencies below 30 MHz and up to 27dB in excess of the FCC Part 15 emission limits at frequencies above 30 MHz. The measuring receiver was set to scan across the PLT carrier frequencies in 5 kHz increments for frequencies below 30 MHz and in 60 kHz increments for frequencies above 30MHz.

Leakage emission levels for frequencies below 30 MHz are shown on Fig. 5

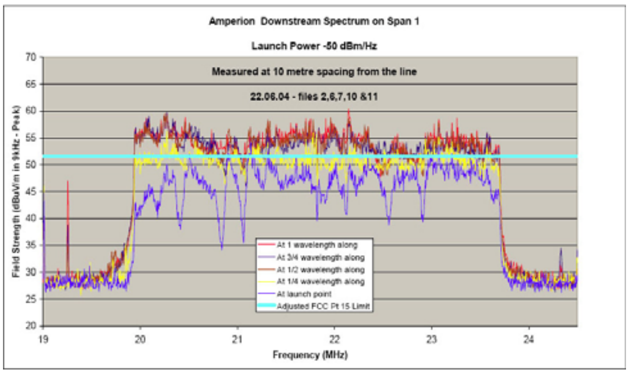

Fig. 5 - *Leakage emission levels for frequencies below 30 MHz*

Leakage emission levels for frequencies above 30 MHz are shown on Fig. 6

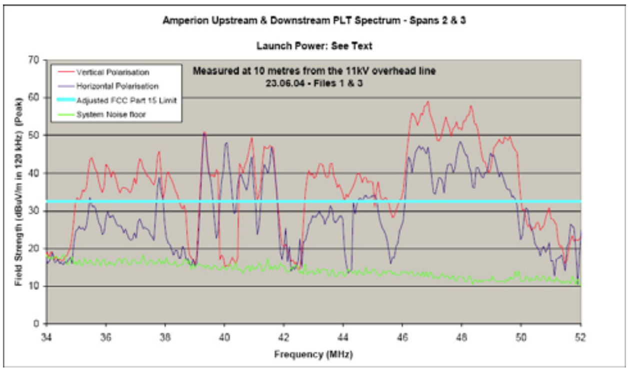

Fig. 6 - *Leakage emission levels for frequencies above 30 MHz*

CONCLUSION

Installing cabling without regard to sources of electromagnetic interference can be detrimental to network performance and transmission quality. There are two effective methods to help protecting cabling systems against EMI, shielding and physical separation. In shielding, noise voltage is induced into a foil or braid surrounding the twisted pairs, instead of onto the conductors. When designing and installing shielded cabling systems, the grounding/earthing and bonding have to be very carefully considered. The other way in which a telecommunications cabling system can be protected from EMI is to ensure some degree of physical separation between the telecommunications cabling lines, cross-connects, electrical power lines, distribution panels.

For frequencies below 30 MHz radiated leakage emissions the Amperion based PLT network operating at its maximum power setting of -50dBm/Hz exceeded the FCC Part 15 limits by up to 8dB. It is concluded that the maximum launch power levels would need to be restricted to approximately -60dBm/Hz to ensure compliance with FCC Part 15.

For frequencies above 30MHz radiated leakage emissions the Amperion based PLT network operating at its maximum power setting of -50dBm/Hz exceeded the FCC Part 15 limits by up to 27dB. It is concluded that the Amperion PLT product as tested is not and cannot be, FCC part 15 compliant above 30MHz.

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Dr. Mićo Gaćanović was born in 1952. He is recognized and known internationally as a scientist in the field of applied electrostatics, where he has given his contribution through original solutions, which are patented in 136 countries throughout the world and applied in production.

He received many prestigious world-known awards and certificates for his creative work. Hence, he is included in the work of world groups of creativity, research and new technology in Brussels, Moscow, Pittsburgh and other world cities. He is also involved in research projects from the field of theoretical electrical engineering in Germany, Belgium and Russia.